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$$(3)\ x=\sin 2x=2x-\frac{8x^3}{3\,!}+\frac{32x^5}{5\,!}-\frac{128x^7}{7\,!}+\frac{512x^9}{9\,!}+.....$$

$$\therefore y=0 \text{ or } 1=\frac{8x^2}{3\,!}-\frac{32x^4}{5\,!}+\frac{128x^6}{7\,!}-\frac{512x^8}{9\,!}+\frac{2048\,x^{10}}{11\,!}-.....$$

By reversion of series, $x=.94775$, nearly.
$2x=108°\ 36'$, nearly. $x=54°\ 18'$, nearly.

137. Proposed by L. C. WALKER, A.M., Professor of Mathematics, Colorado School of Mines, Golden, Col.

The first transvectant of the binary cubic and its second transvectant is the *cubicovariant* of the binary cubic.

Solution by G. B. M. ZERR, A.M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa., and W. G. GREENWOOD, A. B., Professor of Mathematics, McKendree College, Lebanon, Ill.

Let $u=ax^3+3bx^2y+3cxy^2+dy^3$, be the binary cubic. Then the second transvectant is

$$\frac{d^2u}{dx^2}\frac{d^2u}{dy^2}-\left(\frac{d^2u}{dxdy}\right)^2=0=(ac-b^2)x^2+(ad-bc)xy+(bd-c^2)y^2.$$

This is the Hessian of the cubic.
Let $v=(ac-b^2)x^2+(ad-bc)xy+(bd-c^2)y^2$.
The first transvectant of u, v is

$$\frac{du}{dx}\frac{dv}{dy}-\frac{du}{dy}\frac{dv}{dx}=0.$$

$$\therefore 3(ax^2+2bxy+cy^2)[ad-bc)x+2(bd-c^2)y]$$
$$-3(bx^2+2cxy+dy^2)[(ad-bc)y+2(ac-b^2)x]=0.$$

$$\therefore (a^2d-3abc+2b^3)x^3+3(abd-2ac^2+b^2c)x^2y$$
$$+3(2b^2d-bc^2-acd)xy^2+(3bcd-ad^2-2c^3)y^3=0.$$

This is the cubicovariant of the cubic u.

PROBLEMS FOR SOLUTION.

ARITHMETIC.

170. Proposed by J. F. LAWRENCE, A. B., Breckenridge, Mo.

Suppose the market value of 5% bank stock to be $11\frac{1}{9}\%$ higher than 8% corporation bonds; I realize 8% on my investment, and my income from each is \$180; what did I invest in each?

171. Proposed by JOHN S. ROYER, Editor of The School Visitor, Columbus, Ohio.

A drawer made of inch boards is 8 inches wide, 6 inches deep, and slides horizontally. How far must it be drawn out to put into it a book 4 inches thick, 6 inches wide, and 9 inches long?

ALGEBRA.

183. Proposed by W. J. GREENSTREET, M. A., Editor of The Mathematical Gazette, Stroud, England.

Find the condition that $x:y:z$ may be real, given that $\Sigma ax^2=\Sigma aax=0$, and $\Sigma aa^2=1$.

184. Proposed by J. A. CALDERHEAD, B.Sc., Professor of Mathematics, Curry University, Pittsburg, Pa.

If m rows, viz., the h_1th, h_2th, ..., h_mth, be transferred so as to become the 1st, 2d, ..., mth, without altering the relative positions of the remaining rows, and that n columns, viz., the k_1th, k_2th, ..., k_nth, be similarly transformed, the determinant thus obtained is the same as the original or differs from it only in sign according as $h_1+h_2+.....+h_m-\frac{1}{2}m(m+1)+k_1+k_2+.....k_n-\frac{1}{2}n(n+1)$ is odd or even. [*Muir.*]

GEOMETRY.

205. Proposed by L. C. WALKER, A.M., Professor of Mathematics, Colorado School of Mines, Golden, Col.

Having given any two systems of conjugate semi-diameters of an ellipsoid, the parallelopiped which has any three for continuous edges is equal to that which has the other three for continuous edges.

206. Proposed by W. J. GREENSTREET, M. A., Editor of The Mathematical Gazette, Stroud, England.

$ABCD$ is circumscribed by a circle center O, and it circumscribes a circle radius r. The perpendiculars from C on the sides are x, y, z, u. Show that $\frac{1}{2}AC.BD=r\Sigma x$.

CALCULUS.

170. Proposed by W. J. GREENSTREET, A. M., Editor of The Mathematical Gazette, Stroud, England.

Find the center-locus of conics having 4-point contact with a given conic at a given point. Show that the conic of minimum eccentricity is given by $e^4ab^2\varphi+4e^2-4=0$, where e is its eccentricity, and φ is the angle which the linear center-locus above makes with the normal to the curve at the point.

171. Proposed by J. E. SANDERS, Hackney, Ohio.

A thread passes spirally around a *rough* cylinder 10 feet high and 6 inches in diameter. How far will a pigeon fly in unwinding the thread if the distance between the coils is 4 inches, and the thread *unwound* is at all times *horizontal?*